Conflict Prediction and Resolution Technology Field Test

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The Center/TRACON (Terminal Radar Approach Control) Automation System (CTAS) conflict-prediction capability, developed for the Descent Advisor function, was recently expanded and improved. The new CTAS conflict-prediction function processes all flight phases (climb, cruise, descent). A trial planning function was added to help the user confirm that a conflict-resolution trajectory is conflict-free before issuing a clearance to an aircraft. It was desirable to field test the conflict-prediction function stand-alone before re-integration with the Descent Advisor and other planned technologies for user-preferred trajectories. For field test purposes, the conflict-prediction and conflict-resolution functions were incorporated into a stand-alone tool that displays conflict information and helps the controller quickly build and check a trial plan route using turn vector, direct route, altitude, or speed changes.

The tool was field tested at the Denver Air Route Traffic Control Center September 8–25, 1997. During Phase I (first week) the objective was to obtain a quantitative comparison of conflict prediction and resolution with and without the aid of the tool. One hundred tool-aided conflict resolutions were developed by test controllers and stored for analysis, but they were not communicated to sector controllers on duty. Actual conflict resolutions for the corresponding conflict pairs were also observed and recorded. Part (a) of the first figure shows the distribution of tool-aided resolution types used by test controllers. The second part of the figure shows the actual resolutions issued by the sector controllers for the corresponding set of conflicts. As shown, test controllers were able to resolve 44% of the conflicts by sending one aircraft directly to a future point along its planned route, whereas sector controllers used a direct route in only 12% of the conflicts. A direct route shortens the aircraft path and requires one less clearance (radio communication) by the controller. The 12% no-resolution cases (part (a)) are cases in which trial plans were accepted that predicted less than legal separation between the aircraft. This anomaly is believed to be a result of improper use of the tool caused by limited training. The no-action cases (part (b)) are cases in which the aircraft were not vectored by the sector controller because there was adequate separation.

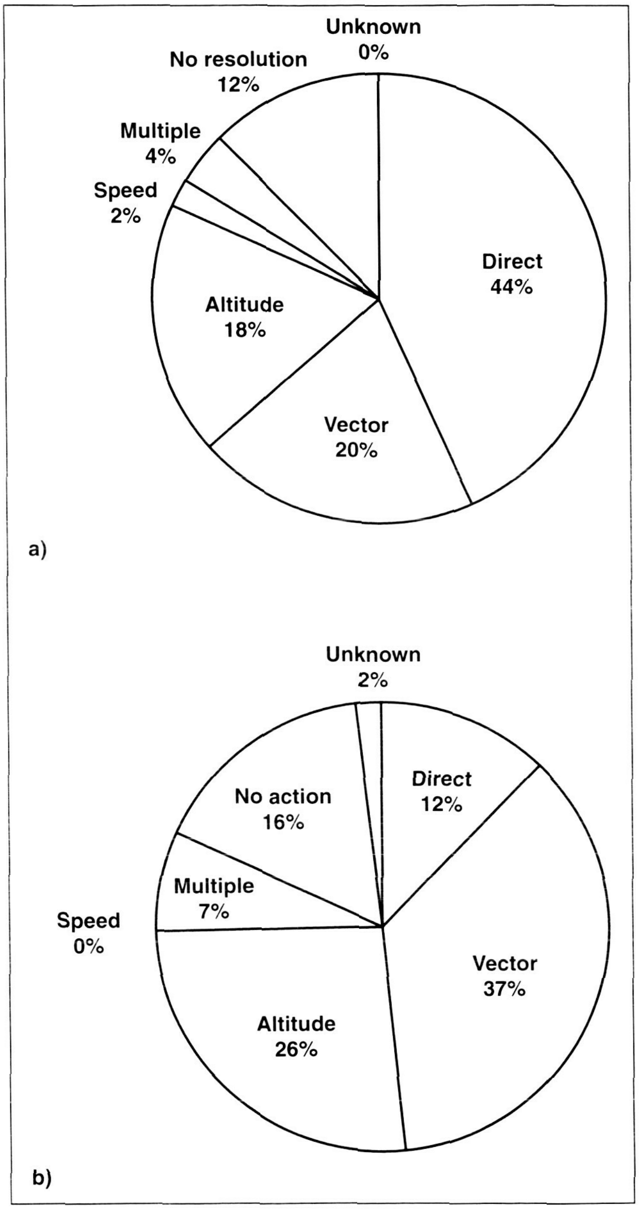

Fig. 1. Resolution types used (a) by test controllers and (b) by sector controllers.

During Phase II (second and third weeks) the tool was set up next to the sector controller positions at

Sectors 16, 17, and 28. The second figure shows the tool at Sectors 16 and 17. Conflict-resolution trajectories were developed by test controllers using the tool, and the trajectories were then suggested to the sector controllers for clearance to the aircraft. During 88 sector-hours of testing, 175 tool-aided resolutions were suggested to sector controllers and about 72% of these resulted in clearances to aircraft. Compared with the Phase I results, there was a 26% increase in the number of direct route resolution clearances actually issued to aircraft. The tool's ability to confirm that a trial plan resolves a conflict and does not create other conflicts was consistently rated as "highly beneficial" by the controllers.

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Fig. 2. Conflict prediction and resolution tool setup at Sectors 16 and 17, Denver Center, September 1997.

Conflict Probe Performance Evaluation

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A conflict probe is a software tool that assists air traffic controllers in maintaining safe separation between aircraft by predicting conflicts up to 20 minutes in advance, using information on aircraft state (track data), intent (flight plans), and atmospheric conditions (wind and temperature). Such a tool would be especially useful in a "free-flight" environment, which is expected to have a less structured traffic flow than is afforded by the current operating environment. The objective of this research is to develop a comprehensive method for quantitatively evaluating the performance of any conflict probe, and then to apply the method to the Center/TRACON (Terminal Radar Approach Control) Automation System (CTAS) Conflict Probe Tool developed at Ames Research Center.

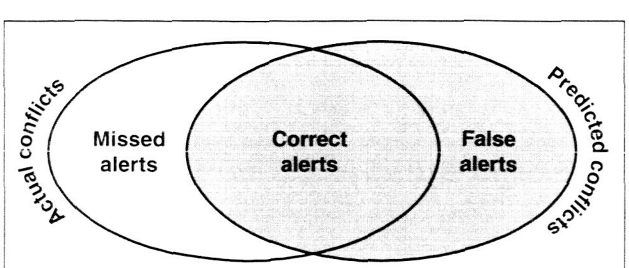

Fig. 1. Schematic of conflict probe primary metrics.

Several metrics of conflict probe performance have been developed and evaluated. The missed-alert rate and false-alert rate are primary metrics that quantify the reliability of a conflict probe. As shown in the first figure, missed alerts are actual conflicts that were not predicted, false alerts are conflicts that were predicted but did not actually occur, and correct alerts are conflicts that were predicted and actually occurred. The mean conflict warning time and root-mean-square errors in key conflict prediction parameters such as minimum horizontal and vertical separations are important secondary metrics that quantify the accuracy of a conflict probe. The CTAS Conflict Probe Tool was exercised with almost 4000 tracks of actual traffic data from the Denver Air Route Traffic Control Center, using expanded conflict windows (see the second figure). Techniques have been developed to identify those conflicts associated with imprecise intent information (e.g., controller clearances not entered as flight plan